High-Pressure Combustion Testing Reveals Promise of Low-Emission Combustors for Advanced Subsonic Gas Turbines

NASA Lewis Research Center's new, world-class, 60-atm combustor research facility, the Advanced Subsonic Combustion Rig (ASCR), is in operation and producing highly unique research data. At operating pressures to 800 psia, emissions of nitrogen oxides were reduced by greater than 70 percent with an advanced fuel injector designed at NASA Lewis. Data, including exhaust emissions and pressure and temperature distributions, were acquired at high pressures and temperatures representative of future subsonic engines. Results to date represent an improved understanding of the formation of nitrogen oxides at these high pressures (twice the pressure of previous combustor tests) and temperatures.

For greater fuel efficiency and performance, future aircraft jet engines will run at higher pressures. This will require new combustor designs to keep the nitrogen oxide and carbon monoxide emissions at environmentally acceptable levels.

To verify the emissions characteristics of gas turbine engines, researchers must duplicate the actual pressures and temperatures found in gas turbine combustors in a laboratory environment. Recognizing this, the U.S. aircraft gas turbine industry identified a need for a national facility that could duplicate the severe inlet conditions of future combustors.

Because of NASA Lewis' expertise in combustion emissions reduction research and in the design and operation of high-pressure test facilities, the Center was seen as the natural location for such a facility. In addition, as a national laboratory, Lewis could provide these facilities to all U.S. gas turbine engine manufacturers while protecting their proprietary interests. The Advanced Subsonic Combustion Rig (see the figure) provides pressures to 60 atm at inlet temperatures to 1300 °F and air flow rates up to 38 lb/sec. This represents a doubling of the pressure capability for combustion testing at Lewis and provides a unique continuous flow facility for the nation. Furthermore, the facility offers state-of-the-art diagnostic methods for characterizing advanced combustor concepts.

Lewis continues to work closely with the gas turbine industry so that this low-emissions combustor technology is successfully transferred into engine prototype hardware. Complementary tests in Lewis' currently available 30-atm test facilities are also underway, taking advantage of Lewis' unique laser diagnostic capabilities. After potential combustor concepts are screened in the 30-atm facilities (which simulate aircraft cruise conditions), the most promising will undergo further testing at actual takeoff and advanced cycle cruise conditions in the new 60-atm rig. Utilization of these test facilities and the expertise of both NASA and its industry partners will enable multiple combustor concepts to be conceived and developed in a shorter period of time, bringing new and better low-emission

combustors to market sooner. Research performed in the Advanced Subsonic Combustion Rig will make it possible for U.S. engine manufacturers to produce environmentally superior commercial engines, enabling them to compete on a worldwide basis.

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